Chapter 12

Static Equilibrium

Static Equilibrium

- SE means that all the particles of the system are at rest
  - a single particle at equilibrium: net force acting on the particle is zero
    - SE: equilibrium + velocity of the particle is zero
  - a rigid object at equilibrium: net force is zero and net torque is zero
    - SE: equilibrium + velocity is zero + angular velocity is zero
- 3D case is complicated! Will only discuss the 2D case:

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum \tau_z = 0$$

Center of Gravity

- Combination of gravitational forces acting on parts of the object is equivalent to a single gravitational force acting through the center of gravity $\vec{r}_{CG}$

$$\vec{\tau} = \sum \vec{r}_i \times m_i \vec{g} = \frac{\sum m_i \vec{r}_i}{M} \times M\vec{g} = \vec{r}_{CM} \times M\vec{g}$$

$$M = \sum m_i \vec{r}_i$$

center of gravity = center of mass
provided ***g*** is uniform

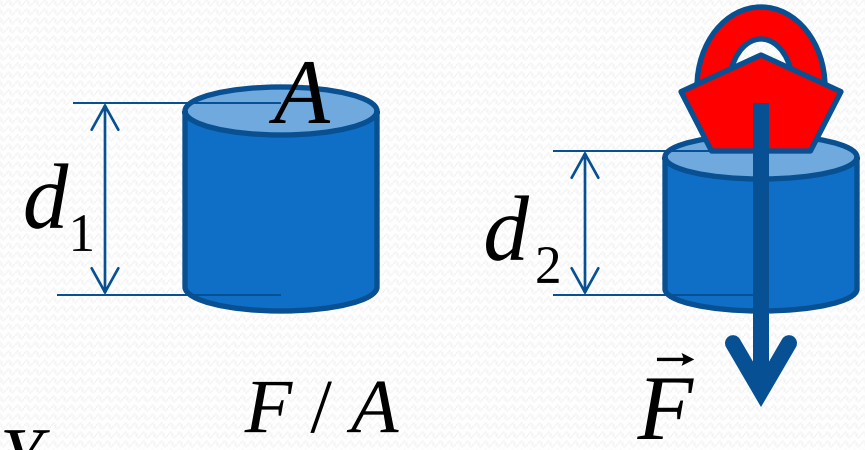
Elastic Properties of Solids

- Rigid object is an abstraction – real objects always deform under stress
- Stress = force per unit cross sectional area
- Strain = relative amount of deformation
- Strain ~ stress (Hooke's law)

$$\text{Elastic modulus} = \frac{\text{stress}}{\text{strain}}$$

Types of elasticity

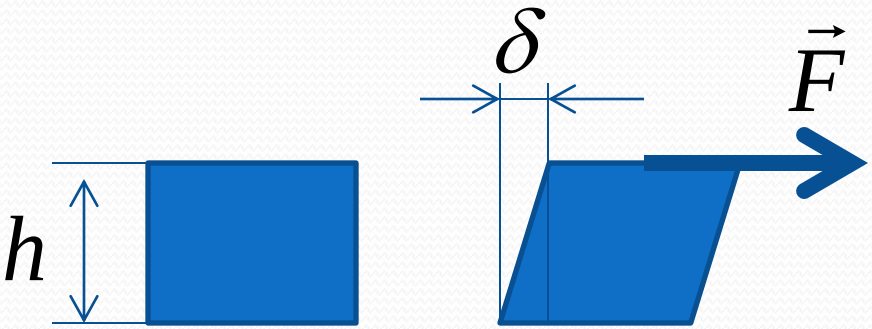
- Elasticity in length



$$Y = \frac{F/A}{(d_1 - d_2)/d_1}$$

Young's modulus

- Elasticity of shape

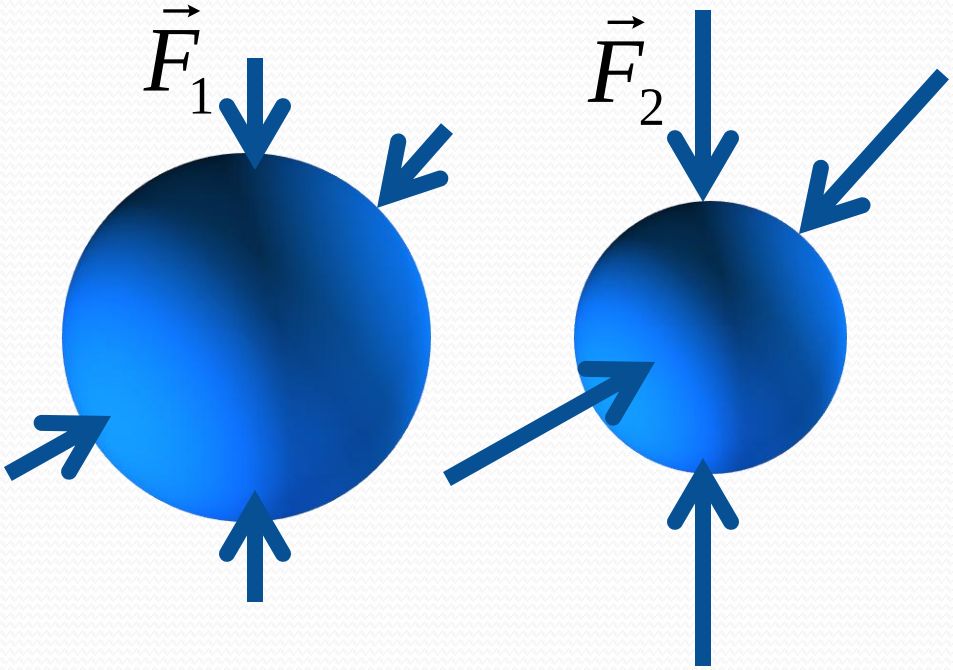


$$Y = \frac{F/A}{\delta/h}$$

shear modulus

Types of elasticity

- Elasticity in volume



$$B = \frac{\Delta F / A}{\Delta V / V} = \frac{\Delta P}{\Delta V / V}$$

bulk modulus